Space Weather Technical Forecast

Issued on Wednesday, 14 February 2024 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Chance G1 Minor Storms Day 1 (14 Feb) due to possible CME arrival. Isolated M-flares likely, and slight chance X-flares. S1 Minor Radiation Storm expected to continue to ease.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity in the last 24 hours with two M1.0 flares at 14/0310UTC and 14/0735UTC, from AR3582 and AR3576 respectively. There are eight sunspot regions on the visible disc, with AR3576 persisting as the largest and most complex region, having seen some growth of positive spots around the main leader, and maintaining a delta configuration within its northern extent. AR3582 and AR3583 are the next largest regions. There is some slight complexity with AR3582, which persists as a pair of closely located bi-poles, however AR3583 is simplifying with intermediate spots showing signs of fading, and with the region spreading into a more open configuration. A further region, potentially significant, is expected on the northeast limb due to recent observed flare activity and notable looping visible on SDO imagery, for now assessed as Hsx/Alpha but this classification expected to change.

No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds as recorded by DSCOVR/ACE were generally background to slight-elevated 350-450km/s. Density was at or near below average levels. Interplanetary magnetic field (IMF) Bt, was at weak levels, 2-7nT. The north-south directed field, Bz, varying weakly between -6 and 6nT. Phi angle was positive (away from the Sun). Geomagnetic activity was mostly Quiet to Unsettled (Kp1-3), but with one Active (Kp4) interval 13/1500-1800 UTC. Geomagnetic activity was mostly Quiet to Unsettled (Kp1-3), but with one Active (Kp4) interval 13/1500-1800 UTC.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was above the S1 Minor Radiation Storm through the period, but has generally followed a sustained declining trend, falling to 20pfu at times. Flux values showed another slight rise from around 14/0800UTC, likely in response to recent large far-side activity, but now looking to be continuing a slow decline. GOES16 high energy (greater than 2MeV) electron flux remained at background. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The fluence at 14/0000UTC was 2.01e6 pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with the likelihood of further isolated M-flares, and a slight chance of X-flares. These most likely from AR3576 in the southwest.

Solar Wind / Geomagnetic Activity: There is one CME still thought to have the potential to influence the near Earth environment, this associated with the M9 flare on 10 Feb. This was originally expected on 13 Feb, but with a late arrival still possible into day 1 (14 Feb) though any potential impacts from this feature this looking increasingly limited as time goes on. Solar winds

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

are currently slightly elevated, with recent CME influence has now perhaps receded. Any CME arrival during day 1 (14 Feb) may lead to more disturbed winds but in the increasingly likely absence of significant enhancement winds expected to persist at around 400-450 km/s before slowly easing to background through the period. A chance of Active to G1 Minor Storm intervals day 1 (14 Feb), otherwise mainly Quiet activity expected, with a decreasing chance of Unsettled intervals.

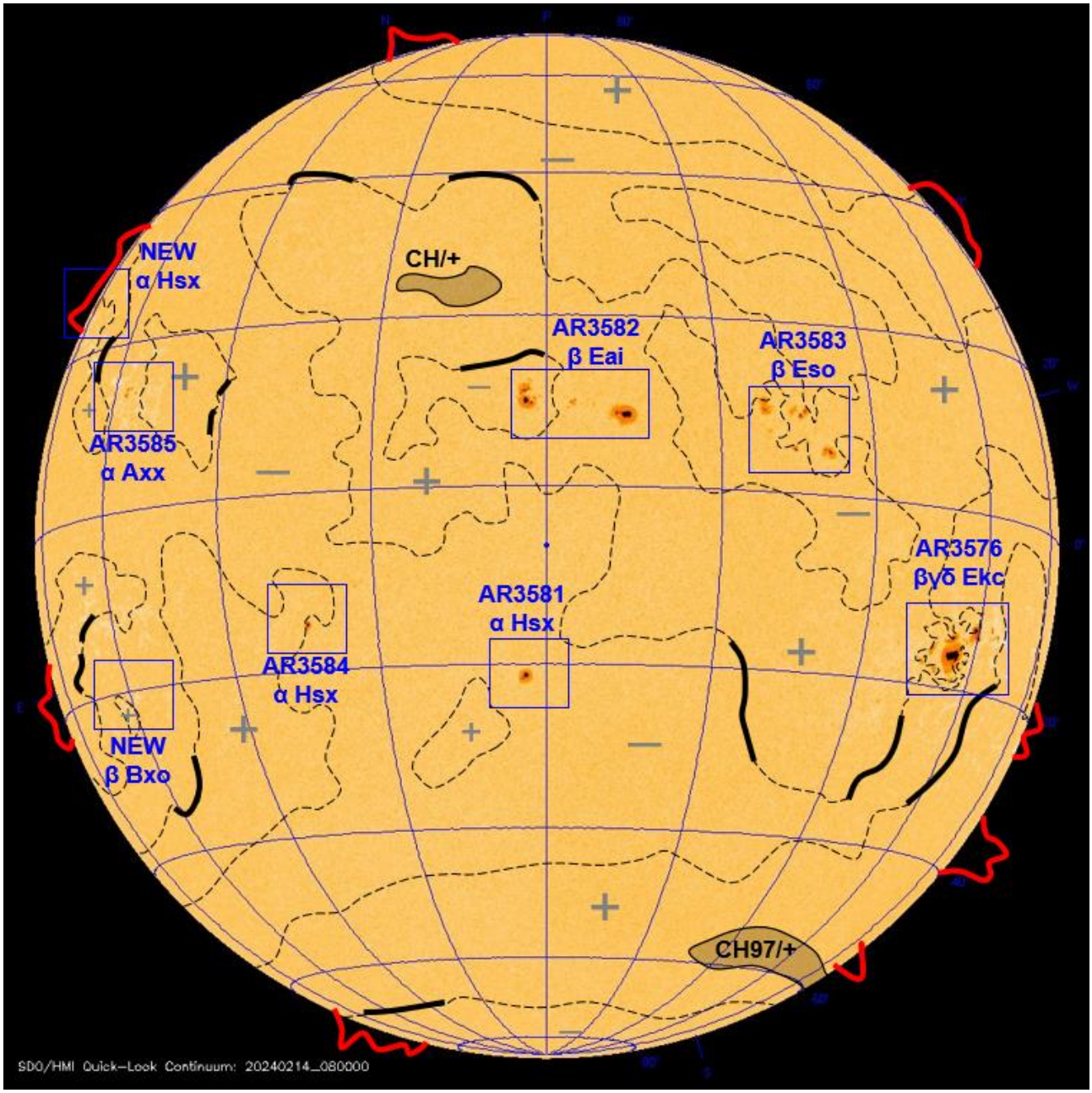
Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently at the S1 Minor Radiation Storm, but on a slowly declining trend, likely falling below this level into day 2 (15 Feb) but likely remaining above background throughout. Further enhancements are possible given any large flares, predominately from AR3576 which is moving into a favorable near west-limb location for causing observable proton evens at Earth.

High energy electron flux (greater than 2MeV) is expected to be at background at first with a chance of rising to Moderate into the period given any further CME influence day 1 (14 Feb). The associated 24-hour electron fluence is expected to stay below the active threshold, but perhaps with a rising trend later in the period.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1. Solar Analysis Valid 14/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

There is one CME still thought to have the potential to influence the near Earth environment, this from the M9 flare associated with AR3576 on 10 Feb. This was originally expected on 13 Feb, but with a late arrival still possible into day 1 (14 Feb) though any potential impacts from this feature this looking increasingly limited as time goes on.

Solar winds are currently slightly elevated, with recent CME influence has now perhaps receded. Any CME arrival during day 1 (14 Feb) may lead to more disturbed winds but in the increasingly likely absence of significant enhancement winds expected to persist at around 400-450 km/s before slowly easing to background through the period, There are no coronal hole enhancements expected, with coronal hole 97 likely too far south to influence solar wind at Earth.

A chance of Active to G1 Minor Storms is maintained for day 1 (14 Feb) given a chance of CME arrival, but this risk generally looks to be reducing. Otherwise mainly Quiet activity expected, with a decreasing chance of Unsettled intervals, although the risk of activity increases late in the period given the continued threat of further CME activity, most probably associated with AR3576.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	1	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0330	Partial halo shock. Material to NE	M9.0 AR3579 plus subsequent filament lift	S-centre, deflected NE	810 km/s	Early 14 Feb	Originally expected late 13 Feb, but not yet observed.

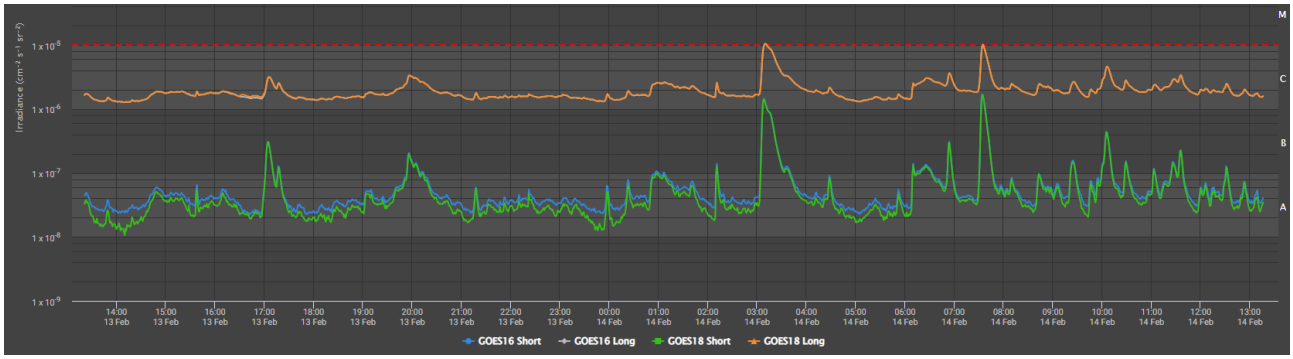
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Low to Moderate activity is expected with the ongoing likelihood of isolated M-flares. There remains a slight chance of X-class flares. These most likely from AR3576 in the near term with the persistence of multiple delta spots within the region maintaining the complexity and consequently the potential for significant flares. This region rotates over the west limb by day 4, however the flare risk from this region will likely continue until the end of the period.
AR3582 in the just west of the north-centre disc and AR3583 near the north-centre disc are also moderately sized regions, however these have a simpler magnetic configuration, and a horizontally aligned field, giving a lower potential for notable flares. Both these regions remain relatively stable with limited growth observed. Also of interest is a new region moving onto the northeast disc. This region likely the source of a M2.6 flare from over the limb on 12 Feb. Further complexity is expected to emerge in the coming hours and days with significant looping still visible over the limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	60
Very Active	R3 to R5 X Class	No	15	15	15	10

Figure 2: Latest 24hr GOES16-18 X-Ray Trace



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

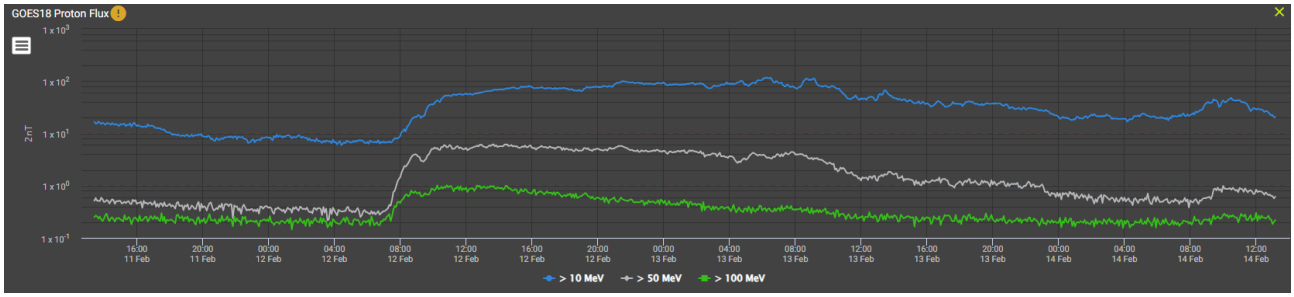
© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
GOES 18 high energy (greater than 10MeV) protons remain enhanced due to recent large far-sided flaring, most likely originating from Ex-AR3575 rotating towards the centre of the far-side disk. The most recent of these was observed with a fast CME leaving the southwest limb on SDO imagery early on the 13 Feb. Observed proton flux was steady at S1 Minor Radiation Storm levels on a slowly declining trend. Flux expected to continue declining through the period, likely falling below the S1 level during day 2 (15 Feb) in the absence of further significant flare activity.

There is a slight chance of further enhancements, most likely from AR3576, given any significant flares, This is due its location in the western disc, which is favorable for any protons to be directed towards Earth.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	100	30	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: GOES 18 Proton flux since 11 Feb, showing periods of S1 and S2 Radiation Storms. Associated with the flaring of AR3575, now on the far-side.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

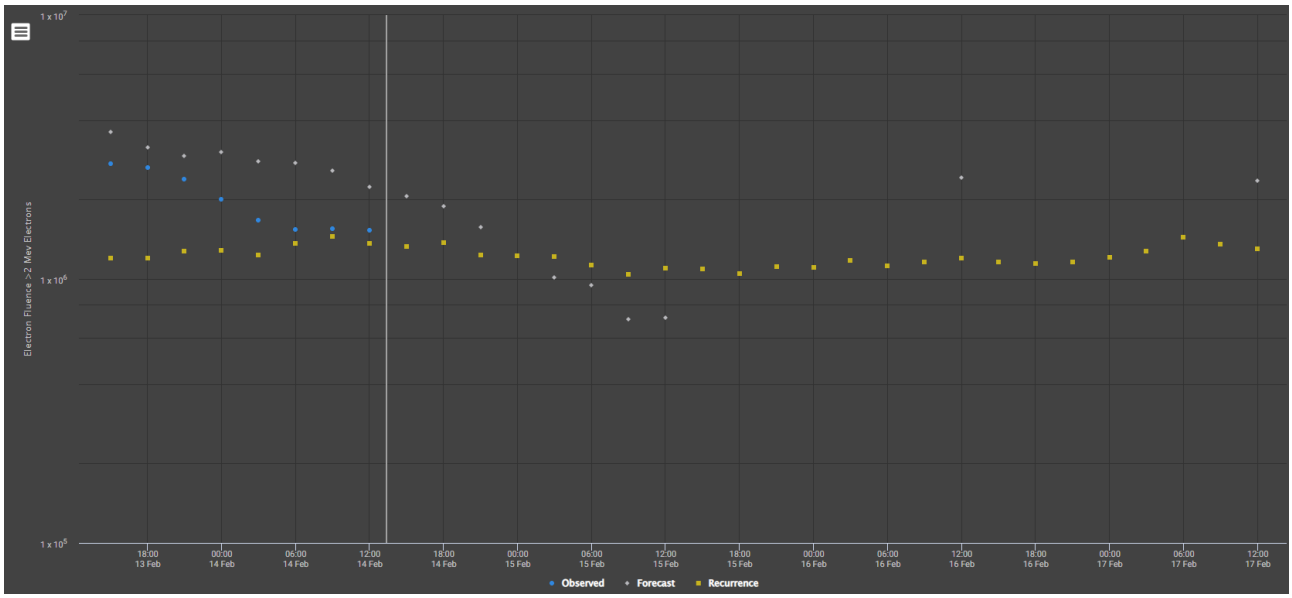
© Crown Copyright 2024. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is forecast to persist at background, with the CME arrival on 12 Feb weak. Although this will depend somewhat on the strength of any enhancement from any further transient CME activity on day 1 (14 Feb). A strong arrival could populate the Van Allen Belts, but also initially compressing them inside of GEO. As any enhancement eases, and these expand outwards again, flux could rise to Moderate with a very slight chance of peaking briefly at High from day 2 onward (15 Feb)
The associated 24 hour electron flux is expected to remain well below the Active (1e8 integrated pfu) threshold, but may see an increasing trend later in the period. REFM thought to be giving generally good guidance in the absence of any significant further CME arrivals.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.